Changing doctor prescribing behaviour, a systematic review

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Published in:
Pharmacy World & Science

Publication date:
1999

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Pharm World Sci 1999;21(4): 158-167.

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Keywords Control Groups, Intervals, Interventions

Abstract
The aim of this overview was to identify interventions that change doctor prescribing behaviour and to derive conclusions for practice and further research. Relevant studies (indicating prescribing as a behaviour change) were located from a database of studies maintained by the Cochrane Collaboration on Effective Professional Practice. This register is kept up to date by searching the following databases for reports of relevant research: DHSS-DATA; EMBASE; MEDLINE; SIGLE; Resource Database in Continuing Medical Education (1975-1994), along with bibliographies of related topics, hand searching of key journals and personal contact with content area experts. Randomised controlled trials and non-equivalent group designs with pre- and post-intervention measures were included. Outcome measures were those used by the study authors. For each study we determined whether these were positive, negative or inconclusive. Positive studies (+) were those that demonstrated a statistically significant change in the majority of outcomes measured at level of $p \leq 0.05$ between the intervention and control groups. Negative studies (-) showed a significant change in the opposite direction and inconclusive studies (≈) showed no significant change compared to control or no overall positive findings.
We identified 79eligible studies which described 96 separate interventions to change prescribing behaviour. Of these interventions, 49 (51%, 41%-61%) showed a positive significant change compared to the control group but interpretation of specific interventions is limited due to wide and overlapping confidence intervals.

Accepted December 1998

Introduction

In recent years, drug expenditure in many health care systems has grown rapidly and varies from 8.4% (USA) to 25.6% (Portugal) [1]. The total costs of drugs prescribed by general practitioners is four times that of drugs prescribed by hospitals. This rise is due to a number of factors and measures have been introduced within the last decade to limit this expenditure, including shift from secondary to primary care [2]. Prescribing is one of the most important health care interventions, however there are frequently gaps between optimal prescribing and that achieved in practice [3]. Interventions have been targeted at both patients (e.g. increasing prescription charges) and doctors (e.g. feedback of information on drugs and costs). Despite these measures there remain wide variations in prescribing costs and volume within both the primary and secondary sectors.

In the United Kingdom, over two-thirds of general practitioner contacts end with the issuing of a prescription although decisions made by hospital doctors exert considerable indirect influence on general practitioner prescribing [2].

Reviews of improving prescribing in both hospital [4] and ambulatory settings [5] are not new. Systematic reviews have also been published which examine the broad questions of effectiveness of methods to improve professional practice [6,7,8]. However, focused reviews of effectiveness of specific interventions to change doctor prescribing behaviour are lacking.

Our aim was to identify interventions that affect prescribing behaviour and to derive conclusions for practice and further research. This review was intended to provide an overview of interventions that influence prescribing with subsequent specific reviews following.

Methods

Data source

Relevant studies (indicating prescribing as a behaviour change) were located from a database of relevant studies maintained by the Cochrane Collaboration on Effective Professional Practice (CCEPP) up to May 1996 [9]. This register is kept up to date by searching the following databases for reports of relevant research: DHSS-DATA; EMBASE; MEDLINE; SIGLE; Resource Database in Continuing Medical Education (1975-1994), along with bibliographies of related topics [8], hand searching of key journals and personal contact with content area experts.

Selection of studies

The following inclusion criteria were adopted:-

- Study design - randomised controlled trials (RCT) and non-equivalent group designs with pre post measures. In the latter studies, participants are allocated by some means other than chance to treatment or control groups [10]. Studies were included if the intervention(s) was compared with a no intervention control or normal practice group.
- Types of participants - physicians only (includes those undergoing postgraduate training).
- Types of intervention - professional interventions as described by Bero et al [9].

That is distribution of educational materials; conferences or educational meetings; interventions that involve locally deriving consensus recommendations; educational outreach visits that take place in the participants location; the influence of local opinion lead-

Table 1 *Quality criteria for RCTs*

Trial	*Concealment of allocation*	*Follow up of professionals*	*Follow up of patients/ episodes*	*Blind Assessment*	*Baseline measurement*	*Reliable outcome measure*	*Protection against contamination*	*Score*
RCT - unit of analysis = physician or practice								
Hershey 1988 (78)	✔	✔	±	✔	✔	✔	✔	13
Schectman 1995 (79)	±	✔	±	✔	✔	✔	±	11
Johnson 1976 (80)	✔	±	✔	±	✔	✔	±	11
Hershey 1986 (81)	±	✔	±	✔	✔	✔	±	11
Meyer 1991 (82)	±	±	✔	✔	✔	✔	±	11
White 1985 (83)	±	±	±	✔	✔	✔	✔	11
Gelbach 1984 (84)	±	×	±	✔	✔	✔	±	9
Landgren 1988 (85)	±	±	✔	✔	✔	✔	✔	12
Putnam 1985 (86)	±	✔	✔	±	±	✔	±	10
Stergachis 1987 (87)	×	±	✔	✔	±	±	×	7
McDonald 1984 (88)	×	±	±	✔	±	✔	±	8
Karuza 1995 (89)	±	✔	✔	✔	✔	✔	✔	13
Hopkins 1980 (90)	×	✔	✔	✔	±	±	×	8
Cowan 1992 (91)	×	✔	×	✔	±	×	±	6
Tierney 1986 (92)	±	±	±	✔	±	✔	×	8
Lobach 1994 (93)	±	×	×	×	✔	±	±	5
Gullion 1988 (94)	±	✔	×	✔	±	✔	✔	10
Stergachis 1990 (95)	±	✔	✔	✔	✔	✔	±	12
Avorn 1992 (96)	±	✔	×	±	±	±	✔	8
Avorn 1983 (97)	±	✔	✔	✔	✔	✔	✔	13
Bjornson 1990 (98)	±	±	±	✔	±	±	±	8
Denig 1990 (99)	±	✔	±	✔	✔	✔	✔	12
McDonald 1976 (100)	✔	±	±	±	±	±	±	8
Palmer 1985 (101)	±	±	±	±	×	✔	✔	8
Steele 1989 (102)	✔	✔	✔	✔	✔	✔	±	13
McConnell 1982 (103)	±	✔	✔	✔	×	✔	±	10
Maiman 1988 (104)	±	✔	✔	✔	±	±	±	10
McAlister 1986 (105)	±	✔	±	±	±	±	±	8
Ornstein 1991 (106)	±	✔	×	✔	✔	±	±	9
Soumerai 1993 (107)	±	✔	±	×	×	✔	±	7
Berings 1994 (108)	✔	✔	±	±	✔	±	✔	11
Jones 1993 (109)	✔	✔	±	✔	✔	✔	±	12
RCT - unit of analysis = patient or episode of care								
Weingarten 1989 (110)	×	✔	✔	±	±	±	×	7
Johnson 1978 (111)	×	±	✔	✔	✔	±	×	8
Becker 1989 (112)	±	±	×	±	±	±	×	5
Rogers 1982 (113)	±	±	×	✔	±	±	×	6
Kroenke 1990 (114)	±	±	✔	±	✔	±	±	9
Coe 1977 (115)	±	±	✔	✔	✔	✔	×	10
Garrett 1986 (116)	✔	±	±	±	±	×	×	6
Britton 1991 (117)	×	±	±	✔	✔	✔	±	9
Belcher 1990 (118)	✔	±	×	✔	✔	✔	✔	11
White 1989 (119)	±	✔	×	±	±	±	±	7
Rosser 1992 (120)	✔	±	±	✔	✔	✔	×	11
Manheim 1990 (121)	±	±	±	✔	±	✔	×	8
Bryce 1995 (122)	✔	±	✔	✔	✔	±	×	10
Lipton 1992 (123)	×	✔	✔	✔	✔	±	±	10
Anderson 1994 (124)	±	±	±	×	✔	✔	✔	9
Owens 1990 (125)	±	±	±	✔	✔	✔	×	9
Billault 1995 (126)	±	±	✔	±	✔	±	×	8
Rubenstein 1989 (127)	±	✔	✔	±	✔	±	✔	11
Cheney 1987 (128)	±	±	✔	±	±	✔	±	9
Lipton 1994 (129)	✔	✔	✔	✔	✔	✔	×	12
Rodman 1984 (130)	✔	±	±	✔	✔	✔	✔	12
Rosser 1991 (131)	✔	✔	×	✔	✔	±	±	10
White 1987 (132)	±	✔	✔	✔	✔	✔	±	12
Billi 1987 (133)	×	×	×	✔	✔	±	✔	7
Buffington 1991 (134)	±	±	±	✔	×	✔	✔	9
Wilson 1988 (135)	±	✔	✔	✔	✔	✔	✔	13
Katon 1995 (136)	±	±	✔	✔	✔	±	×	9
Browner 1994 (137)	✔	✔	✔	✔	✔	✔	±	13
White 1984 (138)	✔	±	✔	✔	±	✔	×	10
Linn 1980 (139)	✔	✔	✔	±	±	±	✔	11
German 1987 (140)	±	±	✔	±	✔	✔	±	10
Frame 1994 (141)	±	±	±	✔	✔	✔	±	10

✔ = done; ± = not clear; and × = not done and each given a score of ✔ = 2; ± = 1; and × = 0

ers (educational influentials); patient mediated interventions in which information given to or received from patients is intended to influence professional practice; audit and feedback where physicians receive summary information on their practice over time; reminder systems where physicians receive specific reminders at the time of intervention to enhance a particular strategy or behaviour; marketing, in which physicians are targeted by interventions similar to those used to market commercially specific desired practices. These were either single or in combination (multifaceted interventions).

One of the authors (PG) verified that all studies met the inclusion criteria.

Data extraction

Eligible studies were assigned to each author and the following categories of data extracted: 1) study design; 2) setting of care; 3) academic status (i.e. teaching or non-teaching); 4) country; 5) clinical problem/area; 6) types of interventions ; and 7) outcome measures used by the study authors. For each study we determined whether these were positive, negative or inconclusive. Positive studies (+) were those that demonstrated a statistically significant change in the majority of outcomes measured at level of $p \leq 0.05$ between the intervention and control groups. Negative studies (-) showed a significant change in the opposite direction and inconclusive studies (≈) showed no significant change compared to control or no overall positive findings. No attempt was made to contact the authors for missing data.

We estimated the proportion of statistically significant studies and approximate 95% confidence intervals using the approach originally described by Clopper and Pearson and cited in Hedges and Olkin [11].

In addition, quality criteria were assessed independently by each author [9]. PG also checked results of these criteria on 40 of the eligible studies.

Results

One-hundred and forty-five studies were located from the Cochrane Collaboration on Effective Professional Practice Register of which 66 were excluded. Reasons for exclusion were: 1) interrupted time series [12-21]; 2) does not deal exclusively with physician prescribing behaviour or with professional interventions [22-56]; 3) there was no control/normal practice intervention group [57-69]; 4) data were missing to determine outcomes between intervention and control [70-76]; and 5) includes a summary paper of a trial published in another journal [77].

Quality criteria

For RCTs the following quality criteria were assessed: concealment of allocation; follow up of professionals; follow up of patients/episodes; blind assessment; baseline measurement; reliable outcome measure; and protection against contamination (Table 1). Quality criteria for non-equivalent group design studies included: baseline measurement; characteristics of studies using second site as control; blind assessment; protection against contamination; follow-up of patients; reliable outcome measures; and follow-up of professionals (Table 2).

Each item was scored as done; not clear or not done [9]. These were then given scores 2, 1 and 0 respectively. Maximum total score for each study was 14 with a mean of 9.65 (sd 2.01) (Tables 1 and 2). Furthermore, there was no difference in the mean quality score before and after the 1990 date of publication (t-test, mean difference -0.44 [-1.35, 0.47]).

Settings

Sixty-five (82%) of the studies were based in the USA; 3 each in Canada and the UK; 2 each in Australia and Israel; and 1 each in Mexico, Netherlands, Belgium and France (Table 3).

Over a third (31) of the studies took place in outpatient settings; 25 in community settings; 12 in hospitals; and 10 in two settings. It was not possible to characterise the setting in one study [98].

Twenty-seven took place in wholly teaching and 14 in mixed centres; 12 in non-teaching settings; and in 26 studies the teaching status was not clear.

Interventions included in the evaluations included attempts to modify prescribing practices in a variety of clinical areas [78-82 84 86 97 101-102 107 111 114 116-117 121 123 125 127 129 132-133 144 150-151 154]; chronic conditions such as diabetes mellitus [93 100] and asthma [119 122 142]; cardiovascular [83 94 98 105 113 115 126 130 132]; infections [85 95 103-104 146]; preventive care [88-89 91-92 106 110 112 118 120 124 128 131 134-135 137-138 141 147 152 155-156]; psychiatric [96 108 136 140 150]; gastrointestinal [109 109 145 148]; musculo-skeletal [87,143]; surgical conditions [90 139] and problems in childhood [156].

Table 2 *Quality criteria for non-equivalent group design studies*

Trial	*Baseline measurement*	*Characteristics of studies using second site as control*	*Blind assessment*	*Protection against contamination*	*Reliable outcome measures*	*Follow-up of professionals*	*Follow-up of patients*	*Score*
Non equivalent group design - physician or practice as unit of analysis								
Gorton 1995 (142)	±	×	±	✔	✔	✔	±	9
Petersen 1995 (143)	✔	×	✔	✔	✔	✔	±	11
McDonald 1976 (144)	±	±	✔	✔	✔	✔	✔	12
Raisch 1990 (145)	✔	✔	✔	✔	×	✔	✔	12
Klein 1981 (146)	✔	✔	✔	±	±	±	±	10
Schreiner 1988 (147)	✔	×	±	✔	±	±	±	8
Gutierrez 1994 (148)	✔	✔	✔	±	±	×	±	9
Ray 1986 (149)	×	×	✔	✔	±	✔	±	8
Mason 1993 (150)	±	±	±	✔	±	±	±	8
Non equivalent group design - patient or episode of care as unit of analysis								
Koepsell 1983 (151)	±	✔	✔	✔	✔	×	×	9
Tape 1993 (152)	±	✔	✔	±	✔	±	✔	11
Margolis 1992 (153)	±	±	✔	×	✔	✔	±	9
Fortner 1985 (154)	✔	✔	✔	±	±	±	±	10
Rodney 1983 (155)	±	±	✔	✔	±	±	±	9
Zimmerman 1994 (156)	✔	±	✔	✔	✔	±	✔	12

✔ = done; ± = not clear; and × = not done and each given a score of ✔ = 2; ± = 1; and × = 0

Table 3 *Studies of effects of interventions on prescribing behaviour of doctors*

Study	*Setting*	*Academic status*	*Clinical Area*	*Intervention*	*Outcome*
RCT - unit of analysis = physician or practice					
Hershey 1988 (78)	USA - outpatient	teaching	All clinical areas	Audit and feedback	≈
Schectman 1995 (79)	USA - outpatient	mixed	Antiulcer drugs	Audit and feedback	≈
Johnson 1976 (80)	USA - outpatient	not clear	All clinical areas	Audit and feedback	≈
Hershey 1986 (81)	USA - outpatient	mixed	All clinical areas	Audit and feedback	+
Meyer 1991 (82)	USA - outpatient	teaching	All clinical areas	Audit and feedback	≈
White 1985 (83)	USA - inpatient	mixed	Acute MI	Conferences + Educational materials	+
Gelbach 1984 (84)	USA - community	teaching	All clinical areas	Educational materials + Audit and feedback	+
Landgren 1988 (85)	Australia - inpatient	mixed	Infections	Educational materials + Outreach	+
Putnam 1985 (86)	USA - mixed	not clear	All clinical areas	Educational materials + Outreach + audit and feedback	≈
Stergachis 1987 (87)	USA - mixed	not clear	non-steriodals	outreach	≈
McDonald 1984 (88)	USA - outpatient	teaching	Influenza	Audit and feedback	+
Karuza 1995 (89)	USA - mixed	mixed	influenza	Conferences + Audit and feedback	+
Hopkins 1980 (90)	USA - inpatient	teaching	Surgical emergencies	educational materials	≈
Cowan 1992 (91)	USA - outpatient	teaching	Vaccinations	Audit and feedback	≈
Tierney 1986 (92)	USA - outpatient	teaching	Preventive care	Audit and feedback	+
Lobach 1994 (93)	USA - community	non-teaching	Diabetes mellitus	Audit and feedback	+
Gullion 1988 (94)	USA - mixed	non-teaching	Hypertension	Conferences + Audit and feedback	≈
stergachis 1990 (95)	USA - outpatient	not clear	Upper respiratory infections	Patient mediated	≈
Avorn 1992 (96)	USA - community	not clear	Psychoactive drugs	educational materials + audit and feedback	≈
Avorn 1983 (97)	USA - community	not clear	Variety of clinical areas	i) educational materials ii) educational materials + audit and feedback	i) ≈ ii) ≈
Bjornson 1990 (98)	USA - not clear	not clear	Heart failure	educational materials	≈
Denig 1990 (99)	Netherlands - community	unclear	Irritable Bowel Syndrome	educational materials	≈
McDonald 1976 (100)	USA - outpatient	non-teaching	Diabetes	audit and feedback	+
Palmer 1985 (101)	USA - community	mixed	Variety of clinical areas	educational materials + conferences + audit and feedback	≈
Steele 1989 (102)	USA - outpatient	teaching	Variety of clinical areas	i) Outreach + audit and feedback ii) Audit and feedback	≈ ≈
McConnell 1982 (103)	USA - outpatient	non-teaching	Upper respiratory tract infections	Outreach	+
Maiman 1988 (104)	USA - community	not clear	Otitis media	i) Educational materials ii) Educational materials + conferences	i) + ii) ≈
McAlister 1986 (105)	Canada - community	not clear	Hypertension	Educational materials + patient mediated + audit and feedback	≈
Ornstein 1991 (106)	USA - community	teaching	Preventive care	i) conferences + patient mediated + audit and feedback ii) conferences + audit and feedback iii) conferences + patient mediated	i) ≈ ii) ≈ iii) ≈
Soumerai 1993 (107)	USA - inpatient	mixed	Blood transfusion	conferences + distribution of educational methods + outreach + marketing	+
Berings 1994 (108)	Belgium - outpatient	non-teaching	Anxiety/insomnia	i) educational materials ii) educational materials + outreach	i) + ii) +
Jones 1993 (109)	England - community	mixed	Dyspepsia	educational materials	+
RCT - unit of analysis = patient or episode of care					
Weingarten 1989 (110)	Israel - community	not clear	Preventive care	Audit and feedback	+
Johnson 1978 (111)	USA - outpatient	non-teaching	All clinical areas	Audit and feedback	≈
Becker 1989 (112)	USA - outpatient	teaching	Preventive care	i) Audit and feedback + patient mediated ii) Audit and feedback	i) ≈ ii) ≈
Rogers 1982 (113)	USA - outpatient	teaching	Hypertension	Audit and feedback	≈
Kroenke 1990 (114)	USA - outpatient	teaching	All clinical areas - Elderly	Audit and feedback	≈
Coe 1977 (115)	USA - outpatient	not clear	Hypertension	Audit and feedback	≈
Garrett 1986 (116)	USA - outpatient	not clear	Variety of clinical areas	Audit and feedback	+
Britton 1991 (117)	USA - outpatient	not clear	Variety of Clinical areas	Audit and feedback	≈
Belcher 1990 (118)	USA - outpatient	mixed	Preventive care	Educational materials + conferences + patient reminders + audit and feedback	≈
White 1989 (119)	England - community	not clear	Asthma	Educational materials + patient reminders +audit and feedback	≈
Rosser 1992 (120)	USA - community	teaching	Preventive care	i) Patient mediated - telephone ii) Patient mediated - letter iii) audit and feedback - computer	i) + ii) + iii) +

Table 3 *Continued*

Manheim 1990 (121)	USA - inpatient	teaching	All clinical areas	Educational materials + conferences + audit and feedback	≈
Bryce 1995 (122)	Scotland - community	not clear	Asthma	Educational materials + patient reminders + audit and feedback	+
Lipton 1992 (123)	USA - mixed	non-teaching	All clinical areas	Patient mediated	+
Anderson 1994 (124)	USA - inpatient	mixed	Preventive care	i) Educational materials + outreach	i) +
				ii) Educational materials + outreach + audit and feedback	ii) +
Owens 1990 (125)	USA - inpatient	teaching	All clinical areas	Audit and feedback + patient mediated	+
Billault 1995 (126)	France - mixed	not clear	hypertension	Patient mediated	≈
Rubenstein 1989 (127)	USA - community	non-teaching	various clinical areas	Educational materials + conferences + audit and feedback	≈
Cheney 1987 (128)	USA - outpatient	teaching	Vaccinations	Audit and feedback	+
Lipton 1994 (129)	USA - inpatient	non-teaching	various clinical areas	Patient mediated + audit and feedback	+
Rodman 1984 (130)	USA - inpatient	teaching	CCU	audit and feedback	≈
Rosser 1991 (131)	Canada - community	teaching	Preventive care	i) audit and feedback - computerised decision support	i) +
				ii) Patient mediated - letters	ii) +
				iii) Patient mediated - telephone	iii) +
White 1987 (132)	USA - inpatient	teaching	Warfarin	audit and feedback - computerised decision support	≈
Billi 1987 (133)	USA - inpatient	teaching	various clinical areas	Educational materials + conferences	+
Buffington 1991 (134)	USA - community	not clear	Vaccination	i) audit and feedback	i) +
				ii) audit and feedback + Patient mediated - letter	ii) +
Wilson 1988 (135)	Canada - community	mixed	Smoking cessation	i) Outreach	≈
				ii) Educational materials + conferences	+
Katon 1995 (136)	USA - community	non-teaching	Depression	conferences + Audit and feedback + patient mediated	+
Browner 1994 (137)	USA - outpatient	non-teaching	Hypercholesterolaemia	i) conferences	≈
				ii) conferences + educational materials	≈
White 1984 (138)	USA - inpatient	teaching	Digoxin intoxication	Audit and feedback	+
Linn 1980 (139)	USA - mixed	mixed	Burn care	Educational materials + conferences + audit and feedback	+
German 1987 (140)	USA - outpatient	teaching	Mental health problems	Audit and feedback	≈
Frame 1994 (141)	USA - community	non-teaching	Vaccination	Audit and feedback -computerised decision support	+
Non equivalent group design - physician or practice as unit of analysis					
Gorton 1995 (142)	USA - mixed	mixed	Asthma	i) Educational materials + conferences	i) ≈
				ii) Educational materials + conferences (computer)	ii) ≈
				iii) Educational materials + conferences (multimedia)	iii) ≈
Petersen 1995 (143)	Tasmania - community	not clear	Allopurinol	Educational materials + outreach	+
McDonald 1976 (144)	USA - outpatient	not clear	Various clinical areas	audit and feedback - computerised decision support	+
Raisch 1990 (145)	USA - community	not clear	Antiulcer drugs	Educational materials + outreach	≈
Klein 1981 (146)	USA - outpatient	teaching	Urinary tract infections	conferences	+
Schreiner 1988 (147)	USA - outpatient	teaching	Vaccination	audit and feedback	+
Gutierrez 1994 (148)	Mexico - community	not clear	Diarrhoea	Conferences + audit and feedback	+
Ray 1986 (149)	USA - mixed	not clear	Diazepam	Educational materials + outreach	≈
Mason 1993 (150)	USA - outpatient	teaching	Variety of clinical areas	Outreach	+
Non equivalent group design - patient or episode of care as unit of analysis					
Koepsell 1983 (151)	USA - outpatient	teaching	All clinical areas	Audit and feedback - computerised decision support	≈
Tape 1993 (152)	USA - outpatient	mixed	Vaccination	Audit and feedback	+
Margolis 1992 (153)	Israel - community	not clear	Childhood problems	Audit and feedback - computerised decision support	+
Fortner 1985 (154)	USA - community	not clear	All clinical areas	conferences + patient mediated + audit and feedback	+
Rodney 1983 (155)	USA - outpatient	teaching	Vaccination	Audit and feedback + conferences	+
Zimmerman 1994 (156)	USA - mixed	not clear	Histamine antagonists	Educational materials + audit and feedback	+

+ = significant outcome; ≈ = non-significant or equivocal outcome

Interventions

Within the 79 eligible studies [78-156], there were 96 separate interventions apart from the non-intervention controls.

To aid presentation, the nine interventions detailed above were grouped into six categories: distribution of educational materials; audit and feedback (includes local consensus processes and reminders); outreach (-includes local opinion leaders); patient mediated; conferences; and marketing.

Table 3 shows that 53 studies reported single interventions and the remaining 26 studies were multifaceted. Of the single interventions, audit and feedback were most common.

Forty-nine (49/96) of the interventions showed a positive significant change compared to the control group (Table 4). Note that none of the studies showed a negative effect as we were interested in those studies that demonstrated a statistically significant change in the majority of outcomes.

Studies that have used patient mediated interventions only yield the highest proportion of positive results. Next come interventions which provide outreach ('academic detailing') and audit and feedback (including reminders). The least effective were distribution of educational materials (43%, 13%-78%).

Of the multifaceted interventions, just under fifty percent (49%, 20%-80%) were positive.

Overall, 51% (41%-61%) of the intervention demonstrated a significant change.

The number of positive results was lower in studies that were set in the USA compared to the other countries (table 5).

There is no difference in the studies reporting a positive result with the proportion of studies above and below the median quality score (table 6).

Discussion

This overview has shown that a number of studies, in primary and secondary settings, are available which address interventions that tend to influence prescribing. The interventions are varied and have been used in various combinations. Further, the majority have been set in the USA and the results may not apply elsewhere.

It is interesting that inspite of the high proportion of studies that show positive results that were unlikely to be accounted for by chance, no clear differences between approaches can be seen, with the exception of the distribution of printed educational materials which has been used widely in combination with other active interventions, but where used alone has proven unimpressive.

Vote counting is an inefficient use of the statistical information in studies, and the poor reporting of results makes the use of more formal methods for pooling data and calculating effect size problematic [11].

Publication bias is the most important potential source of bias in systematic reviews [157]. Although considerable efforts have gone into locating relevant

Table 4 *Types of interventions aimed at changing doctor prescribing behaviour*

		No. of interventions	*Positive findings*	*% Positive interventions*	*95% CI*
Intervention	distribution of educational materials	7	3	43	13, 78
	audit and feedback	33	17	52	34, 66
	outreach	4	2	50	10, 90
	patient mediated	8	5	63	30, 90
	conferences	1	1	100	-
	marketing	0	0	0	-
	multifaceted*	43	21	49	20, 80
	Overall	96	49	51	41, 61

* two or more of the above interventions

Table 5 *Country of study*

Country	*Positive interventions*	*No of interventions*	*% Positive interventions (95% CI)*
USA	36	78	46 (33, 59)
other	13	18	72 (43, 95)

Table 6 *Outcome of studies against score*

		Positive findings	*Total no of studies*	*% Positive studies (95% CI)*
Median quality score	≤9	18	37	49 (32, 65)
	≥10	22	42	52 (34, 63)

studies, it is likely that some have not been included in this review. We decided a priori not to include time series designs. Auto regressive integrated moving average models which are widely used in time series analysis [10], are required to take into account the non independent nature of observations from the same population over time, and this is very rarely robustly undertaken in the literature [3]. However, the relatively small number of time series data sets identified would be unlikely to reverse the results from other included designs in this review. Although randomised trials provide the most valid estimates of effect, time series designs deserve further consideration in the future as they may be used in situations where experimental designs are not possible, such as national guideline implementation programmes or mass media interventions. We found 9 non-randomised trials, which are potentially open to bias, and it was not clear in most cases why a decision had been made not to allocate by chance (and thus increase the validity of the trial results). In future trials randomisation should be considered more frequently [158].

Study limitations

Even though the CCEPP database has been rigorously developed publication bias has to be considered as the search strategy may not have identified important negative results from trials. In addition the database includes studies that use quantitative methodologies (RCTs, Controlled trials and Interrupted Time Series) and valuable results from qualitative studies which provide insight into behaviour change have been excluded.

Data extraction has been difficult, as the reporting of details and results has been incomplete or vague. We did not contact the authors for further clarification of data.

Some of these studies used multiple outcome measures (e.g. number prescriptions/patient and % generic prescribing) and for these studies, a positive finding was that which had majority significant findings.

Studies are also subject to another analysis error where, for example, the unit of allocation is a health care provider but the analysis is based upon the number of patients or pills. This could under power the individual study and thereby increase the chance of a spuriously significant finding [159].

Implications

This review has shown that 51% of interventions studied may have changed prescribing behaviour and a number of research issues are raised. For example, distribution of educational materials alone appear to have little and multifaceted interventions some effect on changing behaviour. Interventions which change doctor prescribing behaviour are complex - there are no "magic bullets" [7]. Further work, in collaboration with the Cochrane Collaboration on Effective Professional Practice [9], is advocated on disentangling the characteristics of these effective interventions that acknowledge the personal, environmental and behavioural factors [160-161]. Also, primary studies are needed which take into account these effective interventions; are multidisciplinary; and which combine both the quantitative and qualitative methodologies.

Acknowledgement

We are grateful to the CCEPP Editorial Base, York, for the use of the database and in particular to Jo Bark for assistance with this study.

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